

DEVELOPMENT AND DISTRIBUTION OF THE YOUNG OF NORTHERN SMOOTH TONGUE, *LEUROGLOSSUS SCHMIDTI* (BATHYLAGIDAE), IN THE NORTHEAST PACIFIC, WITH COMMENTS ON THE SYSTEMATICS OF THE GENUS *LEUROGLOSSUS* GILBERT

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ABSTRACT

Development of the northern smoothtongue, *Leuroglossus schmidti*, is described from yolk-sac larva through pelagic juvenile based on plankton-caught specimens from the northeast Pacific Ocean and eastern Bering Sea.

Larvae of *L. schmidti* may be readily distinguished from those of other bathylagid smelts in the northeast Pacific Ocean and eastern Bering Sea by a combination of myomere counts (47-52), possession of short-stalked eyes, and pigment patterns. Pigment patterns in preflexion larvae about 5-13 mm SL (standard length) consist primarily of two lateral bands, at about 33-40% and 60-64% SL, and dorsal and ventral pigment on the notochord tip. With growth, these bands diffuse into scattered stellate melanophores on the lateral body wall, one on the gut near the anus, and the other on the caudal peduncle. Transformation from larva to juvenile takes place at about 31-35 mm SL, and juveniles acquire dark melanistic pigment characteristic of bathylagid fishes.

Although some bones ossify in relatively small larvae of *L. schmidti*, a number of structures do not calcify until transformation. The general sequence of ossification is cleithrum, dentary and vomerine teeth, pharyngeal teeth, other bones associated with the feeding apparatus, most other cranial bones, caudal fin and, at or near transformation, axial skeleton, median and paired fins, gill rakers, and secondary caudal fin rays.

Larvae of *L. schmidti* are at times the dominant bathylagid taken in plankton samples from the northeast Pacific Ocean and eastern Bering Sea, accounting for up to 5% of the fish larvae collected. Although neither the southern nor northern limits of the spawning range of this species are known, adult *L. schmidti* range from at least southern British Columbia to the central Bering Sea and westward to the Okhotsk Sea.

Based on this study and work of previous authors, *L. schmidti* is considered specifically distinct from *L. stilbius*, and *L. schmidti*, not *L. callorhini*, is considered the correct name. *Leuroglossus* lacks an orbitosphenoid which is present in *Bathylagus*; hence the genus *Leuroglossus* Gilbert is considered to be distinct from *Bathylagus* Günther.

The northern smoothtongue, *Leuroglossus schmidti* Rass, family Bathylagidae, ranges from about southern British Columbia to the Bering and Okhotsk Seas (Borodulina 1968; Peden 1981). Its known congeners are *L. stilbius stilbius* Gilbert, which reportedly ranges from British Columbia to the Gulf of California (Borodulina 1968; Ahlstrom 1969; Peden 1981), and *L. stilbius urotronus* Bussing, which apparently ranges from the eastern tropical Pacific (Ahlstrom 1969) to the Peru Trench (Bussing 1965; Borodulina 1968).

Larvae of *L. schmidti* are at times the dominant bathylagid taken in samples collected from the northeast Pacific Ocean and the eastern Be-

ring Sea, accounting for up to about 5% of the fish larvae collected (Waldron and Vinter²; Kendall et al.³). The larvae usually are taken over the continental slope (Waldron and Vinter footnote 2; Kendall et al. footnote 3) but also occur in coastal waters (Mattson and Wing 1978). Distributional data for larvae and juveniles in the Bering Sea were reported by Waldron [1981], for Kodiak

²Waldron, K. D., and B. M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. Unpubl. manuscr., 88 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112.

³Kendall, A. W., Jr., J. R. Dunn, R. J. Wolotira, Jr., J. H. Bowerman, Jr., D. B. Dey, A. C. Matarese, and J. E. Munk. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak Shelf. Unpubl. manuscr., 393 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112.

¹Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112.

Island by Kendall et al. (footnote 3), and for the eastern Gulf of Alaska by Naplin et al.⁴

Presented here is the first published description of the development of *Leuroglossus schmidti*. Ahlstrom (1965) presented illustrations of 5.4, 15.7, and 28.5 mm SL (standard length) specimens of *L. stilbius stilbius*; subsequently he⁵ presented illustrations of, but did not publish, a size series (8.4, 20.5, and 31.5 mm SL) of *L. schmidti*. Ahlstrom (1969) also described the eggs of *L. schmidti*, *L. s. stilbius*, and *L. s. urotronus* and presented supporting arguments for recognizing *L. schmidti* as a distinct species. Differences of opinion exist over the correct name of *L. schmidti* (Ahlstrom 1965, 1969; Borodulina 1968), its specific status (Hart 1973; Peden 1981), and the validity of the genus *Leuroglossus* Gilbert (Cohen 1956, 1964; Ahlstrom 1968, 1969; Borodulina 1969). I also attempt here to resolve the nomenclature of *L. schmidti*, to confirm the validity of the genus *Leuroglossus* Gilbert, and to describe the known distribution of eggs and larvae of this species in the northeast Pacific Ocean and eastern Bering Sea.

Relatively little is known about the biology of the northern smoothtongue. Adult *L. schmidti* have been taken at the sea surface as well as at depths to 700 m, and larval and juvenile specimens have been found in the stomachs of several species of fish (Hart 1973).

METHODS

Specimens

Larvae and juveniles of *Leuroglossus schmidti* were obtained from plankton samples collected by the Northwest and Alaska Fisheries Center (NAWFC) in the eastern Bering Sea in 1971 and 1976-79 and from the Gulf of Alaska in 1971, 1972, and 1977-79. Several hundred specimens were examined in the course of this study. Additional juvenile specimens were obtained from the collections in the College of Fisheries, University of Washington (UW). Radiographs of *L. schmidti*

were made from juvenile specimens in collections at NAWFC; additional radiographs were obtained from the College of Fisheries, UW.

Comparative material consisting of larvae and juveniles of *Bathylagus pacificus*, *B. ochotensis*, *B. milleri*, and *L. stilbius stilbius* was obtained from collections at the NAWFC and College of Fisheries, UW. Radiographs and cleared and stained specimens of *B. ochotensis*, *B. nigrigenys*, *B. milleri*, *B. wesethi*, *B. bericodes*, *B. longirostris*, and *L. stilbius stilbius* were examined from collections at the Southwest Fisheries Center (SWFC), NMFS, La Jolla, Calif.

Measurements

The following measurements were made on 152 unstained larvae and juveniles, 4.9-55.0 mm SL, using an ocular micrometer in a stereomicroscope.

- Standard length = snout tip to notochord tip until notochord is fully flexed and the posterior margin of the forming hypural bones is vertical, then to posterior margin of hypurals.
- Snout to anus = horizontal distance along midline of body from tip of snout to vertical through posterior edge of the anus.
- Head length (HL) = horizontal distance from tip of snout to posterior margin of cleithrum until no longer visible, then to posteriormost margin of opercle.
- Snout length = horizontal distance from tip of snout to anterior margin of pigmented region of eye.
- Interorbital width = width of fleshy tissue dorsal to the eyes.
- Eye width = horizontal distance through midline of pigmented eye.
- Eye height = vertical distance through center of pigmented eye.
- Body depth at pectoral fin base = vertical distance across body at pectoral fin base.
- Body depth at anus = vertical distance across body at anus.
- Snout to origin of dorsal fin = horizontal distance along midline of body from tip of snout to vertical from origin of dorsal fin.
- Snout to origin of anal fin = horizontal distance along midline of body from tip of snout to vertical from origin of anal fin.
- Snout to origin of pelvic fin = horizontal distance from tip of snout to vertical through origin of pelvic fin.

⁴Naplin, N. A., J. R. Dunn, and K. Niggol. 1973. Fish eggs, larvae, and juveniles collected from the northeast Pacific Ocean, October-November, 1971. Unpubl. manuscr., 83 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112.

⁵E. H. Ahlstrom (deceased), Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, La Jolla, CA 92038, class notes taken by the author in August 1971.

Caudal peduncle depth = minimum vertical distance across caudal peduncle in juvenile specimens.

Caudal peduncle length = medial horizontal distance from vertical through base of terminal anal fin ray to posterior margin of hypural bones in juvenile specimens.

Osteology

To determine the onset and sequence of ossification, counts of meristic structures were made on 102 *L. schmidti* larvae and juveniles (5.9-51.6 mm) cleared and stained with Alizarin Red and Alcian Blue (Dingerkus and Uhler 1977). Structures were considered ossified even if only slightly stained with Alizarin Red. Variation may occur in the ability of specimens to accept alizarin stain because of the variable lengths of time they have been preserved (Dunn 1983). Only general trends in sequences of ossification are, therefore, discussed in this paper.

Counts were made of dorsal, anal, pectoral, pelvic, and caudal fin rays (principal and secondary); neural and haemal spines; abdominal and caudal centra; hypural, epural, and uroneural bones; branchiostegal rays; upper and lower gill rakers; and teeth on the left dentary and palatine as well as all teeth on the vomer and glossohyal.

The sequence of ossification of bones of the cranium, axial skeleton, pectoral and pelvic girdles, and median and paired fins and their supporting bones was traced on the same specimens used for counts of meristic structures. The size of the specimen was noted when individual bones commenced ossification and when bones were consistently ossified. Nomenclature of bones followed Norden (1961) and Borodulina (1969).

Illustrations were made with the aid of a camera lucida. Specimens had been preserved in 3-5% Formalin⁶ buffered either with sodium borate or sodium acetate. Illustrations of caudal fin development were made from cleared and stained specimens.

IDENTIFICATION OF *LEUROGLOSSUS SCHMIDTI*

A series of larval and juvenile specimens from plankton samples was linked together by pigment pattern and myomere counts. Adipose fins

were present in transformed specimens, indicating they were salmoniform or myctophiform fishes; dorsal and anal fins in postflexion larvae formed in the finfold and attached to the body by "streamers" (Ahlstrom 1969; Moser [1981]), indicating the series was argentinoid. Only two branchiostegal rays were formed in postflexion and juvenile specimens, indicating they were bathylagid fishes. Positive identification was based on knowledge of all bathylagid larvae known to occur in the area (Ahlstrom 1965, 1972, footnote 5) and the following meristic characters (Ahlstrom 1969, footnote 5; Borodulina 1968; Peden 1981; this study):

Dorsal fin rays	= 10-11
Anal fin rays	= 11-14
Pectoral fin rays	= 8-9
Pelvic fin rays	= 8-9
Abdominal vertebrae	= 26-29
Total vertebrae	= 47-52
Branchiostegal rays	= 2
Gill rakers	= 8-9+17-19 = 26-27

Larvae of *L. schmidti* can be readily distinguished from larvae of the other bathylagid and argentinid species occurring in the northeast Pacific Ocean and eastern Bering Sea, based on myomere counts, pigment patterns, and noting whether the eyes are attached to long or short stalks. *Leuroglossus schmidti* larvae, with eyes on short stalks, may be distinguished from their more southerly occurring congener *L. stilbicus stilbicus* by their larger myomere number (47-52 vs. 38-42) and differences in pigment patterns. Yolk-sac larvae of the two species have similar pigment patterns and can best be separated by myomere counts. Preflexion larvae of *L. schmidti* have two lateral bands of pigment on the trunk whereas preflexion larvae of *L. s. stilbicus* have two patches, one near the terminus of the gut and one on the ventral body wall near myomere 16 (Ahlstrom 1965, 1972). Postflexion larvae of *L. schmidti* have several (3-8) lateral melanophores on the body whereas those of *L. s. stilbicus* have one or none as shown by Ahlstrom (1965, 1972). *Bathylagus milleri* larvae also lack stalked eyes, have 50-54 myomeres, and, in small larvae (<9 mm), have pigment limited to the ventral body wall and gut near their terminus and on the caudal peduncle; with growth the pigment migrates dorsally, increases to three or four patches, and, in postflexion larvae, is concentrated primarily on the dorsal and ventral body margin and lat-

⁶Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

erally on the caudal peduncle and pectoral fin areas (footnote 5). *Bathylagus ochotensis* larvae have eyes borne on moderately long stalks, lateral body melanophores which increase in number during ontogeny, as shown by Ahlstrom (1972), and possess 46-48 myomeres. *Bathylagus pacificus* larvae have eyes carried on long stalks, possess 44-48 myomeres, and initially (at about 4 mm) only two lateral pigment bands—one near the gut terminus and one near the notochord tip. An additional lateral band of melanophores develops at about 45-50% SL (approximately covering myomeres 14-17) in larvae 5-12 mm long. In larvae larger than about 13 mm, the lateral pigment increases to 3-5 patches over the lower body wall and gut (pers. obs.).

Because of the fragile nature of the eye stalks in bathylagid larvae, specimens frequently have their eyes missing or damaged by the collecting gear. If the eyes of the specimen are missing, then at certain sizes (about 5-13 mm), *L. schmidti* could be confused with *B. pacificus*. In addition to a lower myomere count, *B. pacificus* larvae in this size range have lateral body melanophores at about 40-48% and 64-69% SL, whereas *L. schmidti* have such pigment patches located at about 33-40% and 60-64% SL. Also, the pigment on the notochord tip in *B. pacificus* is longer and covers the lateral wall of the notochord, whereas such pigment in *L. schmidti* is limited to the dorsal and ventral portions of the notochord tip.

Larvae of *L. schmidti* in the northeastern Pacific Ocean may be readily distinguished from more southerly cooccurring argentinid larvae in that the latter are characteristically much more intensely pigmented at nearly all sizes as depicted by Schmidt (1906, 1918), Sanzo (1931-33), and Russell (1976).

DEVELOPMENT OF *LEUROGLOSSUS SCHMIDTI*

(Figures 1, 2, 3)

Pigmentation

Although pigmentation in *L. schmidti* varies among similar size specimens and changes in quantity and location with ontogeny, basic trends persist that provide characters useful in identifying the larvae. Descriptions of pigment patterns are based primarily on 57 larvae (4.9-35.0 mm SL) and on 9 transformed juveniles (31.3-

55.0 mm SL) preserved <3 yr, in which fading of pigment therefore was minimal.

Head Region

Pigment in the head region is limited primarily to the eyes, jaw, and opercle, develops gradually, and is sparse until transformation. In small larvae (about 5.0-6.5 mm), the head and eyes are unpigmented. The eyes are pigmented in 7 mm larvae, and pigment is sometimes present on the tip of the lower jaw. A pigment spot is present on the posterior portion of the opercle in some larvae as small as 16 mm; this pigment is not consistently present until the larvae reach about 30 mm. At this size, and until transformation (about 31-35 mm), the number and size of the opercle melanophores may vary from one or two large melanophores to three or four small pigment spots; the tip of the lower jaw is sometimes pigmented. After transformation, the head becomes heavily pigmented and the opercle acquires dark melanistic pigment.

Preanal Region

In larvae from about 5.0 to 6.5 mm, gut pigment is limited to a single patch of pigment in the middle portion of the gut. By 7 mm, pigment consists of two lateral bands at about 37-40% SL and 60-64% SL. In larvae 11-12 mm, the anterior and posterior pigment bands have begun to spread laterally to form stellate melanophores. As the larvae grow (about 16-24 mm), one or two pigment spots are sometimes present on the ventral gut below the larval pectoral fins; lateral body pigment usually consists of two to eight stellate melanophores or diagonal streaks of pigment. Pigment near the anus consists of a series of three to six melanophores. In larvae 24-34 mm in length, gut pigment continues to be limited to one or two pigment spots below the larval pectoral fins and a few (3-6) melanophores near the anal tube. Lateral body pigment consists of generally three (range 3-5) stellate melanophores. The pigment spots in the gut region persist in various sizes and numbers until transformation, when the juvenile acquires characteristic dark melanistic pigment over the entire region.

Postanal Region

Preflexion larvae (about 5.0-13.0 mm) lack postanal pigment except on the dorsal and ven-

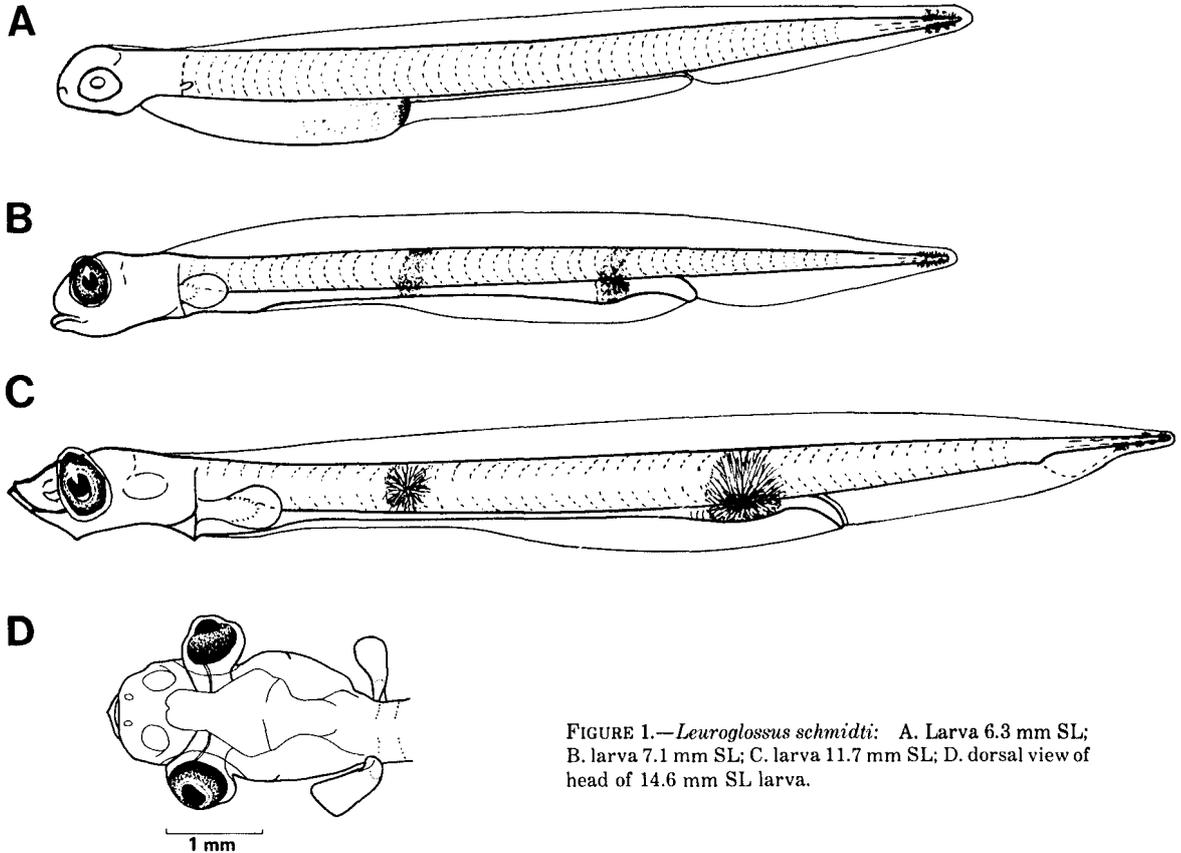


FIGURE 1.—*Leuroglossus schmidti*: A. Larva 6.3 mm SL; B. larva 7.1 mm SL; C. larva 11.7 mm SL; D. dorsal view of head of 14.6 mm SL larva.

tral terminus of the notochord. Dorsal pigment tends to disappear before the pigment on the ventral surface, and notochord pigment is usually lacking in larvae longer than 13 mm. Flexion larvae (13-18 mm) either lack pigment in the postanal region or have a single melanophore in the caudal peduncle region. Postflexion larvae 18-21 mm have zero to two melanophores on the caudal peduncle; larvae from about 22 mm until transformation usually have two lateral melanophores, one on the caudal peduncle and one near the base of the caudal fin rays. After transformation, the juveniles become heavily pigmented with the postanal region covered with small melanophores.

Morphology

(Tables 1, 2)

Larvae of *L. schmidti* are slender, their greatest body depth (about 7-10% SL) occurring at the pectoral fin base. The gut is relatively long,

about 75% SL. Notochord flexion begins at about 13 mm and is completed by 18 mm, although the notochord extends posterior of the hypural bones until transformation (about 31-35 mm). Larvae have a distinctive protruding lower jaw, noticeable at about 7 mm, which becomes more pointed with ontogeny (Figs. 1-3). Eyes are borne on stalks, most noticeable in late flexion larvae (Fig. 1D).

The snout to anus length ranges from about 72% SL in preflexion larvae to nearly 78% SL in postflexion larvae; it is about 74% SL in transformed juveniles. Head length increases as a proportion of standard length from nearly 16% in preflexion larvae to about 29% in transformed juveniles. The eyes are narrow and oblong in larvae. Eye height as a percentage of head length decreases from 39% in preflexion larvae to about 25% in postflexion larvae. Eye width declines as a percentage of head length from nearly 30% in preflexion larvae to about 20% in postflexion larvae.

Interorbital width remains relatively constant,

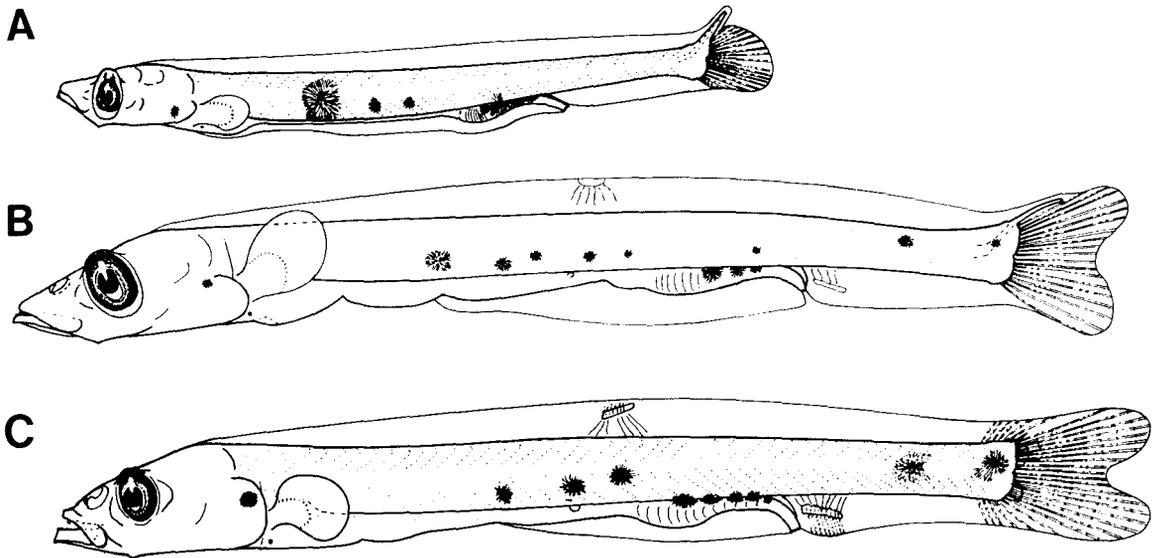


FIGURE 2.—*Leuroglossus schmidti* larvae: A. 16.1 mm SL; B. 24.1 mm SL; C. 33.5 mm SL.

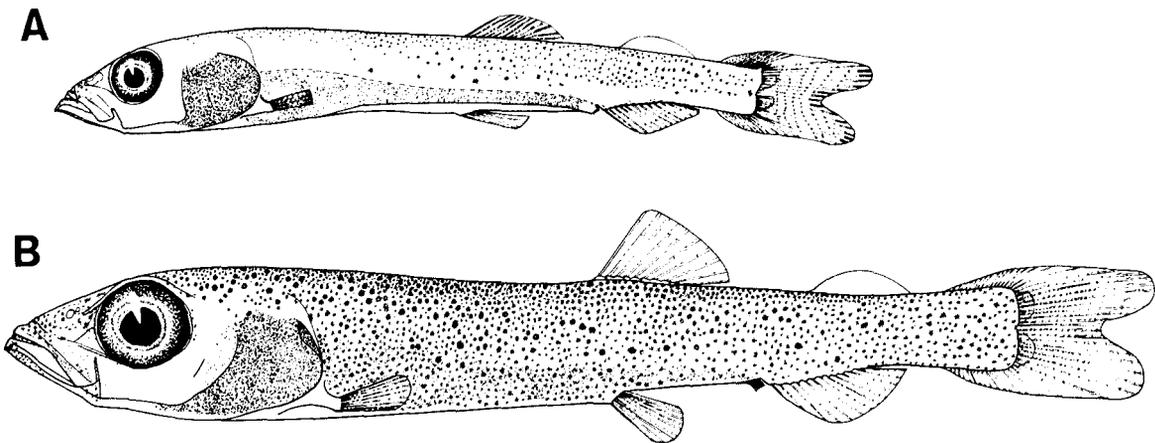


FIGURE 3.—*Leuroglossus schmidti* juveniles: A. 33.1 mm SL; B. 47.8 mm SL.

about 26-30% HL, in larvae but decreases to 22% HL in juveniles. Snout length as a proportion of head length increases from about 24% in preflexion larvae to nearly 32% in postflexion larvae, but declines to about 27% in transformed juveniles. Body depth at the pectoral fin base increases as a percentage of standard length during ontogeny, from about 7% in preflexion larvae to about 14% in transformed juveniles. Body depth at anus also increases during development; in preflexion larvae it is about 5% SL and reaches nearly 9% SL in transformed juveniles.

Larval pectorals are the first fins to form (Fig. 1); pelvic fin buds begin to form in larvae 22-24 mm (Fig. 2B). In postflexion larvae, dorsal and anal fins form in the finfold (Fig. 2B, C) and attach to the body by "streamers" (Ahlstrom 1969) or "hyaline strands" (Moser [1981]).

Considerable morphological changes occur during transformation. The eye stalks disappear and the eyes become round (Fig. 3). Eye height in transformed specimens is nearly 28% and eye width about 29% of head length. The dorsal and anal fins move to attach to the body surface (Fig.

TABLE 1.—Measurements (mm) of plankton-caught larvae and juveniles of *Leuroglossus schmidti*. Specimens between dashed lines are undergoing notochord flexion; specimens between solid lines are juveniles. Numbers in parentheses after measurements indicate sample size for that measurement if different from total sample size.

Length interval (mm)	Sample size (N)	Mean length (mm)	Snout to anus length	Snout length	Head length	Inter-orbital width	Eye width	Eye height	Depth at pectoral fin base	Depth at anus	Snout to dorsal fin length	Snout to anal fin length	Snout to pelvic fin length	Caudal peduncle depth	Caudal peduncle length
4.0-4.9	1	4.9	3.4	0.14	0.36	0.20	0.22	0.19	0.31	0.22					
5.0-5.9	1	5.4	4.1	0.26	0.69	0.19	— (0)	— (0)	0.33	0.25					
6.0-6.9	6	6.57	4.62	0.16(3)	0.78	0.23(2)	0.28(2)	0.37(2)	0.49	0.33					
7.0-7.9	11	7.56	5.43	0.15(5)	1.24	0.34(5)	0.32(5)	0.48(5)	0.51	0.32					
8.0-8.9	7	8.31	5.94	0.33(5)	1.34	0.33(5)	0.36(5)	0.52(5)	0.54	0.36					
9.0-9.9	6	9.47	6.72	0.39(3)	1.49	0.38(3)	0.36(3)	0.49(3)	0.57	0.44					
10.0-10.9	10	10.50	7.67	0.46(5)	1.80	0.53(5)	0.47(5)	0.58(5)	0.74	0.49					
11.0-11.9	3	11.30	8.23	0.64(1)	1.95	0.50(1)	0.48(1)	0.56(1)	0.74	0.48					
12.0-12.9	2	12.35	8.70	0.58(1)	2.17	0.65(1)	0.49(1)	0.54(1)	0.91	0.64					

13.0-13.9	3	13.57	10.33	0.55	2.51	0.45	0.51	0.73	1.10	0.63					
14.0-14.9	5	14.42	10.92	0.68	2.71	0.80	0.58	0.75	1.14	0.70					
15.0-15.9	5	15.58	11.84	0.74	2.99	0.76	0.60	0.77	1.31	0.77					
16.0-16.9	5	16.50	12.90	0.88	3.19	0.94	0.59	0.75	1.39	0.85					
17.0-17.9	5	17.46	12.80	0.95	3.34	0.88	0.69	0.86	1.46	0.88					

18.0-18.9	5	18.20	14.08	1.23	3.74	0.99	0.77	0.97	1.63	1.04					
19.0-19.9	5	19.66	15.40	1.28	4.05	1.10	0.82	1.02	1.74	1.04					
20.0-20.9	5	20.36	15.92	1.51	4.10	1.15	0.77	1.05	1.81	1.08		16.2(1)			
21.0-21.9	5	21.20	16.38	1.33(4)	4.32	1.21(4)	0.73	1.17	1.91	1.19		17.1(1)			
22.0-22.9	5	22.48	17.62	1.43	5.00	1.34	1.11	1.18	2.22	1.32		17.90(3)	12.4(1)		
23.0-23.9	5	23.42	17.62	1.60	4.98	1.47	1.03	1.33	2.20	1.35		17.97(3)			
24.0-24.9	5	24.26	20.86	1.85	5.55	1.45	1.19	1.48	2.30	1.36	13.6(1)	18.82(4)	13.0(1)		
25.0-25.9	6	25.35	21.66	1.83	5.84	1.46	1.29	1.53	2.65	1.52	14.38(4)	20.03	13.85(4)		
26.0-26.9	5	26.42	21.70	1.96	6.08	1.42	1.17	1.46	2.60	1.60	15.03(4)	21.18	14.33(3)		
27.0-27.9	5	27.38	22.82	2.07	6.65	1.64	1.44	1.59	2.91	1.66	15.32	21.88(4)	14.46		
28.0-28.9	5	28.36	24.02	2.13	6.54	1.55(4)	1.33	1.57	2.86	1.70	15.54	22.06	15.26		
29.0-29.9	5	29.14	24.25	2.12	7.04	2.04	1.35	1.66	3.16	1.83	16.88	23.18	16.30(4)		
30.0-30.9	5	30.46	25.17	2.25	7.25	1.66	1.58	1.63	3.38	2.02	17.46	24.26	17.04		
31.0-31.9	1	31.2	25.0	2.3	7.5	2.5	1.4	1.8	3.8	2.0	17.9	25.4	17.5		
32.0-32.9	3	32.43	25.17	2.22	7.56	2.50	1.43	1.69	3.45	2.16	18.43	25.60	17.63		
33.0-33.9	1	33.5	25.9	2.2	7.8	2.2	1.5	1.8	3.6	2.2	18.8	26.2	18.4		
34.0-34.9	1	34.0	26.4	2.4	7.8	2.6	1.5	1.8	4.0	2.3	19.8	26.8	17.6		
35.0-35.9	1	35.0	25.9	2.4	10.0	1.3	2.9	2.6	4.6	2.8	19.3	25.7	19.6		

31.0-31.9	1	31.3	23.5	2.5	8.8	2.6	2.5	2.2	4.2	2.4	18.0	24.1	17.4	1.9	5.1
33.0-33.9	2	33.35	24.95	2.48	9.46	1.58	2.50	2.31	4.51	2.78	19.20	25.70	19.15	2.12	4.91
34.0-34.9	1	34.1	25.3	2.7	10.3	1.6	3.0	2.7	4.9	2.9	19.4	25.9	19.5	2.2	5.0
36.0-36.9	1	36.1	26.2	2.8	10.4	1.9	3.0	2.9	4.3	2.9	20.5	26.8	20.4	2.4	5.8
37.0-37.9	1	37.0	27.6	3.1	11.1	2.4	3.4	3.3	5.4	3.3	22.0	28.5	22.0	2.5	5.6
47.0-47.9	1	47.8	35.4	3.9	14.3	3.9	4.5	4.1	6.7	4.3	27.3	36.6	27.6	3.3	6.9
51.0-51.9	1	51.5	38.6	4.6	15.4	4.2	4.8	4.8	8.3	4.8	30.2	40.0	30.5	3.4	7.4
55.0-55.9	1	55.0	39.2	4.7	16.2	4.2	5.0	5.0	9.2	5.8	31.8	40.5	31.0	4.4	7.8

¹Transforming specimen.

3) and rays develop. Rays develop in the pectoral and pelvic fins. Distinctive "muscle bands," which overlap the base of the caudal fin rays develop in transforming and juvenile specimens (Figs. 2C, 3). The adipose fin develops after transformation (Fig. 3).

Osteology

(Tables 3, 4; Figure 4)

TABLE 2.—Body proportions of larvae and juveniles of *Leuroglossus schmidti*. Values given are percentages: mean, standard deviation, and range (in parentheses).

Item	Preflexion larvae		Flexion larvae		Postflexion larvae		Transformed juveniles	
	Number measured	Values	Number measured	Values	Number measured	Values	Number measured	Values
SL range	47	(4.9-12.7)	23	(13.3-17.8)	73	(18.1-35.0)	9	(31.3-55.0)
Snout to anus length/SL	46	71.8±2.8 (63.5-80.0)	23	75.9±3.4 (66.7-80.7)	73	77.7±1.6 (74.0-80.8)	9	74.0±1.6 (71.3-76.7)
Head length/SL	47	15.7±3.0 (7.0-20.0)	23	19.0±1.6 (16.6-22.8)	73	22.5±2.1 (17.3-28.4)	9	29.2±1.0 (27.5-30.3)
Eye height/HL	23	39.0±13.6 (25.6-78.4)	23	26.2±3.1 (21.6-32.4)	73	24.9±2.6 (17.8-30.6)	9	27.6±2.8 (24.1-31.3)
Eye width/HL	23	29.9±11.9 (22.5-62.8)	23	20.2±2.6 (14.7-24.2)	73	20.4±3.1 (11.3-32.9)	9	29.2±2.0 (25.9-31.5)
Interorbital width/HL	24	29.8±10.3 (18.7-55.6)	23	26.4±6.1 (15.8-38.3)	71	26.6±4.8 (12.9-35.4)	9	22.0±5.4 (15.3-29.4)
Snout length/HL	25	23.8±8.8 (11.1-38.9)	23	26.0±4.1 (14.5-32.4)	72	31.6±3.6 (23.9-46.3)	9	27.4±1.4 (25.7-29.7)
Depth at pectoral fin/SL	47	6.8±1.0 (4.3-9.2)	23	8.3±0.7 (6.9-9.4)	73	10.0±1.1 (8.2-13.1)	9	14.2±1.5 (11.8-16.7)
Depth at anus/SL	46	4.6±0.5 (3.4-5.6)	23	4.9±0.5 (4.2-6.4)	73	6.0±0.7 (4.4-8.0)	9	8.9±0.9 (7.6-10.6)
Snout to dorsal fin length/SL	—	—	—	—	36	56.7±1.5 (53.1-59.3)	9	57.7±0.9 (56.8-59.5)
Snout to anal fin length/SL	—	—	—	—	49	79.0±1.8 (73.4-82.4)	9	76.3±1.6 (73.6-78.6)
Snout to pelvic fin length/SL	—	—	—	—	35	54.6±1.9 (50.6-59.5)	9	57.4±1.4 (55.6-59.5)
Caudal peduncle depth/SL	—	—	—	—	—	—	9	6.7±0.6 (5.9-8.0)
Caudal peduncle length/SL	—	—	—	—	—	—	9	15.0±1.0 (13.3-16.2)

Although a few structures ossify in relatively small *L. schmidti* larvae, a number of skeletal elements do not calcify until the larvae transform into juveniles. Other portions of the skeleton do not completely ossify until well into the juvenile stage. The general sequence of ossification is as follows: cleithrum; dentary and vomerine teeth; pharyngeal teeth; parasphenoid, dentary, maxillary, vomer, premaxillary; most other bones of the cranium; certain elements of the caudal fin and, at or near transformation, axial skeleton; dorsal, anal, and paired fins; and gill rakers and secondary caudal fin rays.

Teeth

Teeth on the dentary and vomer begin to form in 8 mm larvae (Table 3), increasing in number as the larvae grow and doubling in number at transformation. Dentary teeth appear to increase in number with growth in transformed juveniles, but vomerine teeth remain relatively constant in number. In specimens about 12 mm long, one pharyngeal tooth develops on each plate (Table 4); after transformation the teeth then increase to three. Borodulina (1969) also reported three teeth on the pharyngeal plate in adult *L. schmidti*. Teeth on the glossohyal and palatine develop in larvae 16-18 mm long (Table 3). Glossohyal teeth disappear during transformation and are absent in juveniles and adults: hence, the common name "smoothtongue" for *L. schmidti*. A single palatine tooth is present during the larval stage; the number of palatine teeth increases after transformation (Table 3).

Skull

The dentary, maxillary, parasphenoid, and operculum begin to ossify in 14-15 mm larvae (Table 3). In larvae 18-21 mm long, the premaxillary, pre-, sub-, and interopercle bones, vomer, symplectic, branchiostegal rays, and urohyal begin ossifying in some larvae (Tables 3, 4). These structures, however, are not consistently calcified until larvae reach about 28 mm long (32 mm for the urohyal).

Certain bones of the olfactory, orbital, otic, and oromandibular regions and much of the hyoid arch begin to ossify in some larvae 24-26 mm

TABLE 3.—Development of meristic and other structures in *Leuroglossus schmidti* larvae and juveniles. Mean data are given for specimens in the specified length range. Specimens between dashed lines are undergoing notochord flexion; those between solid lines are juveniles.

SL (mm)	Sample size	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin rays	Principal caudal rays		Secondary caudal rays		Neural spines	Haemal spines	Centra			
						Upper	Lower	Upper	Lower			Abdom.	Caudal	Total	
5.9-7.9	12														
8.0-8.9	6														
9.0-9.9	5														
10.0-10.9	1														
11.0-11.9	1														
12.0-12.9	2														

13.0-13.9	1														
14.0-14.9	1														
15.0-15.9	3														
16.0-16.9	1														
17.0-17.9	3														

18.0-18.9	6					2.2	2.0								
19.0-19.9	3														
20.0-20.9	4					4.3	4.5	0.3	0.3						
21.0-21.9	1					10.0	9.0	2.0	2.0						
22.0-22.9	5					2.0	1.8	0.4	0.4						
23.0-23.9	5					4.0	3.6	1.0	1.2		0.4				
24.0-24.9	4					5.0	4.5	1.0	1.3		0.3				
25.0-25.9	5					8.0	7.2	1.2	1.8		0.2				
26.0-26.9	6					6.7	6.0	0.3	0.3						
27.0-27.9	3					6.7	6.0	0.7	1.0			0.7			
28.0-28.9	4					7.5	6.8	3.0	3.0			0.8			
29.0-29.9	4					10.0	9.0	3.0	3.3	0.5	0.8			0.3	0.3
30.0-30.9	4					10.0	9.0	3.3	4.8	0.8	2.0			0.3	12.8
31.0-31.9	2					10.0	9.0	3.0	4.0		0.5			0.5	0.5
32.0-32.9	1					10.0	9.0	2.0	1.0						
33.0-33.9	1					10.0	9.0	5.0	5.0	2.0	2.0			1.0	1.0
34.0-34.9	1					10.0	9.0	4.0	5.0		1.0			1.0	1.0

31.0-31.9	1	10.0	13.0	9.0	8.0	10.0	9.0	13.0	14.0	49.0	23.0	27.0	23.0	50.0	
33.0-33.9	1	10.0	13.0	7.0	9.0	10.0	9.0	13.0	12.0	51.0	24.0	28.0	24.0	52.0	
35.0-35.9	2	10.0	12.5	7.5	9.0	10.0	9.0	14.0	13.5	49.5	23.5	27.0	23.5	50.5	
37.0-37.9	1	10.0	11.0	9.0	9.0	10.0	9.0	15.0	15.0	49.0	24.0	27.0	24.0	51.0	
44.0-44.9	1	10.0	11.0	6.0	9.0	10.0	9.0	15.0	13.0	49.0	23.0	27.0	23.0	50.0	
51.0-51.9	1	10.0	12.0	9.0	9.0	10.0	9.0	15.0	15.0	50.0	24.0	27.0	24.0	51.0	

SL (mm)	Sample size	Hypurals	Epurals	Uroneurals	Branchios-tegal rays	Gill rakers			Teeth						
						Upper	Lower	Total	Dentary	Glossohyal	Vomer	Palatine			
5.9-7.9															
8.0-8.9	6									0.7			0.7		
9.0-9.9	5									0.4			0.4		
10.0-10.9	1														
11.0-11.9	1									2.0			1.0		
12.0-12.9	2														

13.0-13.9	1									2.0			1.0		
14.0-14.9	1									3.0			1.0		
15.0-15.9	3				0.3					2.0			0.7		
16.0-16.9	1									5.0	2.0		3.0		
17.0-17.9	3									3.7	1.7		1.3	0.3	

18.0-18.9	6				0.7					4.0	1.3		2.5	0.2	
19.0-19.9	3				0.7					4.3	1.3		2.0	0.7	
20.0-20.9	4	1.8		0.5	1.0					10.0	2.5		3.0	0.8	
21.0-21.9	1	7.0		2.0	2.0					10.0	3.0		3.0	2.0	
22.0-22.9	5	1.4		0.4	0.4					9.0	3.0		3.0	1.0	
23.0-23.9	5	2.8		1.0	1.2					10.4	2.8		3.0	1.0	
24.0-24.9	4	3.0		1.3	2.0					10.8	2.3		3.0	1.0	
25.0-25.9	5	1.2		1.6	1.2					11.8	2.4		3.0	1.0	
26.0-26.9	6			1.3	1.7					12.0	2.3		3.0	1.0	
27.0-27.9	3	2.3		1.3	1.3					11.0	3.0		3.0	1.0	
28.0-28.9	4	5.3		1.5	2.0					13.0	2.8		3.0	1.0	
29.0-29.9	4	4.8		2.0	2.0					11.8	2.8		3.0	1.0	
30.0-30.9	4	5.0		2.0	2.0			1.0	2.8	3.8	14.0	3.0	3.0	1.0	
31.0-31.9	2	6.0		2.0	2.0					13.0	2.5		3.0	1.0	
32.0-32.9	1			2.0	2.0					14.0	3.0		3.0	1.0	
33.0-33.9	1	7.0		2.0	2.0					12.0	3.0		3.0	1.0	
34.0-34.9	1	7.0		2.0	2.0					11.0	3.0		3.0	1.0	

31.0-31.9	1	7.0		2.0	2.0	7.0	15.0	22.0	24.0	24.0	2.0		6.0	3.0	
33.0-33.9	1	7.0		2.0	2.0	7.0	14.0	21.0	28.0	27.5			9.0	4.0	
35.0-35.9	2	7.0		2.0	2.0	7.0	14.5	21.5	27.5	34.0			6.5	4.0	
37.0-37.9	1	7.0	1.0	2.0	2.0	7.0	14.0	21.0	34.0	32.0			8.0	7.0	
44.0-44.9	1	7.0		2.0	2.0	7.0	17.0	24.0	32.0	46.0			10.0	4.0	
51.0-51.9	1	7.0	1.0	2.0	2.0	9.0	17.0	26.0	46.0	46.0			9.0	5.0	

¹Haemal spines not fully differentiated on one specimen with 50 centra ossifying. It was therefore not possible to determine the number of precaudal vertebrae in that specimen.

TABLE 4.—Sequence of ossification in larvae and juveniles of *Leuroglossus schmidti*. The initial ossification of an element is indicated by X. A dashed line indicates that an element is ossified in some, but not all, specimens; a solid line indicates the element is consistently ossified. A question mark indicates the length at which ossification commences is unknown.

Element	Standard length (mm)																																						
	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	'31.0	'33.0	'35.0	'37.0	'44.0	'51.0					
Olfactory region																																							
Supraethmoid																								X															
Intraethmoid																							X																
Vomer																																							
Nasal																																							
Antorbital																																							
Prefrontal																										X													
Orbital region																																							
Pterosphenoïd																																							
Suborbital																																							
Postorbital																																							
Supraorbital 1																																							
Supraorbital 2																																							
Preorbital																																							
Parietal																																							
Frontal																																							
Dermosphenotic																																							
Otic region																																							
Sphenotic																																							
Pterotic																																							
Prootic																																							
Epiotic																																							
Exoccipital																																							
Neurocranium																																							
Parasphenoid																																							
Opisthotic																																							
Extrascapular																																							
Basioccipital																																							
Supraoccipital																																							
Frontal																																							
Oromandibular region																																							
Premaxillary																																							
Maxillary																																							
Palatine																																							
Ectopterygoid																																							
Quadrate																																							
Mesopterygoid																																							
Angular																																							
Angular																																							
Retroarticular																																							
Coronomeckelum																																							
Hyoid arch																																							
Hyomandibular																																							
Symplectic																																							
Interhyal																																							
Cerathyal																																							
Hypohyal																																							
Urohyal																																							
Basihyal																																							
Epihyal																																							
Glossohyal																																							
Opercular series																																							
Preoperculum																																							
Operculum																																							
Suboperculum																																							
Interoperculum																																							
Branchial arches																																							
Pharyngeal teeth																																							
Hypobranchials																																							
Ceratobranchials																																							
Epibranchials																																							
Pharyngobranchials																																							
Appendicular skeleton																																							
Cleithrum																																							
Posttemporal																																							
Supracleithrum																																							
Scapula																																							
Proximal radials (pectoral)																																							
Basipterygium																																							
Coracoid																																							

formed specimens as are epineural (centra 1-35) and epipleural (centra 17-34) ribs. Predorsal bones (18 in specimens examined) are partially ossified only in one 37.1 mm transformed juvenile, but not in a 51.6 mm specimen.

Appendicular Skeleton

The cleithrum is the first bone to commence ossification (at about 7 mm) in larvae of *L. schmidti* (Table 4), but it is not consistently calcified in larvae <24 mm. The supracleithrum and posttemporal are ossifying in some specimens as small as 15 and 18 mm, respectively. The coracoid is ossified in only one transformed specimen; the scapula and proximal radials of the pectoral fin are not ossified in any transformed specimens. The basipterygium of the pelvic fin is ossified in transformed specimens.

Fins

The caudal fin is the first fin to commence development in *L. schmidti* (Table 3), but secondary rays are not completely formed until after transformation. The caudal complex consists of seven preural and two ural centra (the latter fuses into a single urostyle during ontogeny), two pairs of uroneurals, one epural, and seven hypural bones (Table 3; Fig. 4). There are 10 superior and 9 inferior principal caudal rays. The numbers vary, but generally 15 dorsal and 15 ventral secondary caudal rays are supported by cartilaginous plates, lying between the neural and haemal spines of the caudal complex.

The anlage of the caudal fin is evident in 6.4 mm larvae (Fig. 4a). In 11.5 mm larvae, four cartilaginous hypural bones and the posterior-most haemal spine are evident (Fig. 4b). In a 15.3 mm larvae, three haemal spines and five hypural bones are present in cartilage. The hypural bones support 4+2 unossified principal caudal rays (Fig. 4c). In larvae 18-19 mm long, seven unossified hypural bones are present; they support 10+9 principal caudal rays, variable numbers of which are beginning to ossify (Table 3). The anterior uroneural is discernible but unossified (Fig. 4d). Development of the caudal fin proceeds rapidly in larvae >20 mm. In a 23.1 mm specimen (Fig. 4e) all seven hypural bones, 10+9 principal rays, and 2+2 secondary rays are ossifying. Both pairs of uroneurals are ossified. A single unossified epural and a number of unossified neural and haemal spines can be observed. The

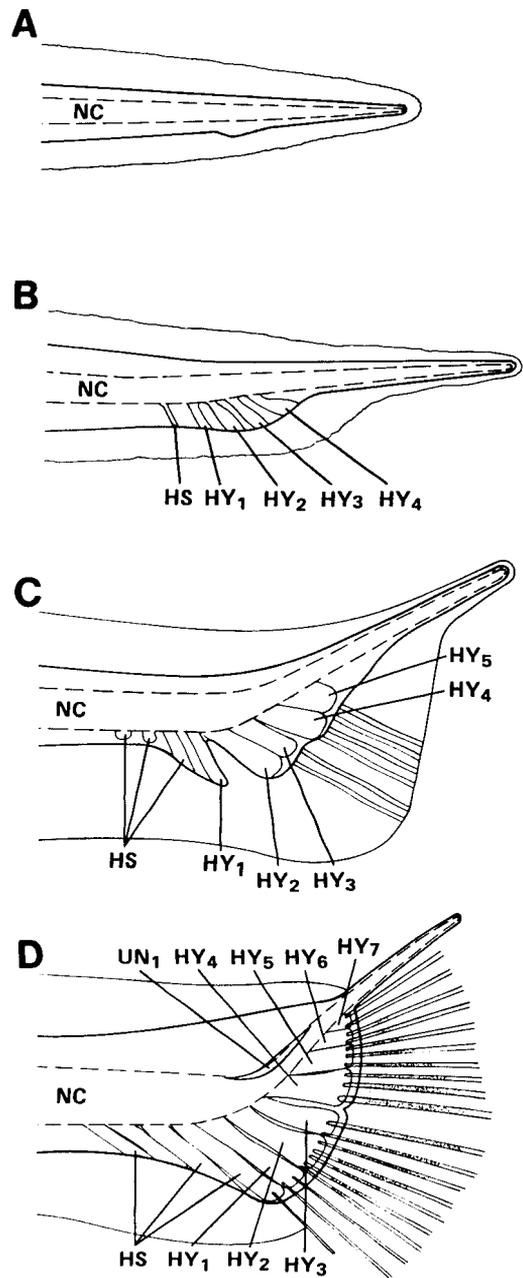
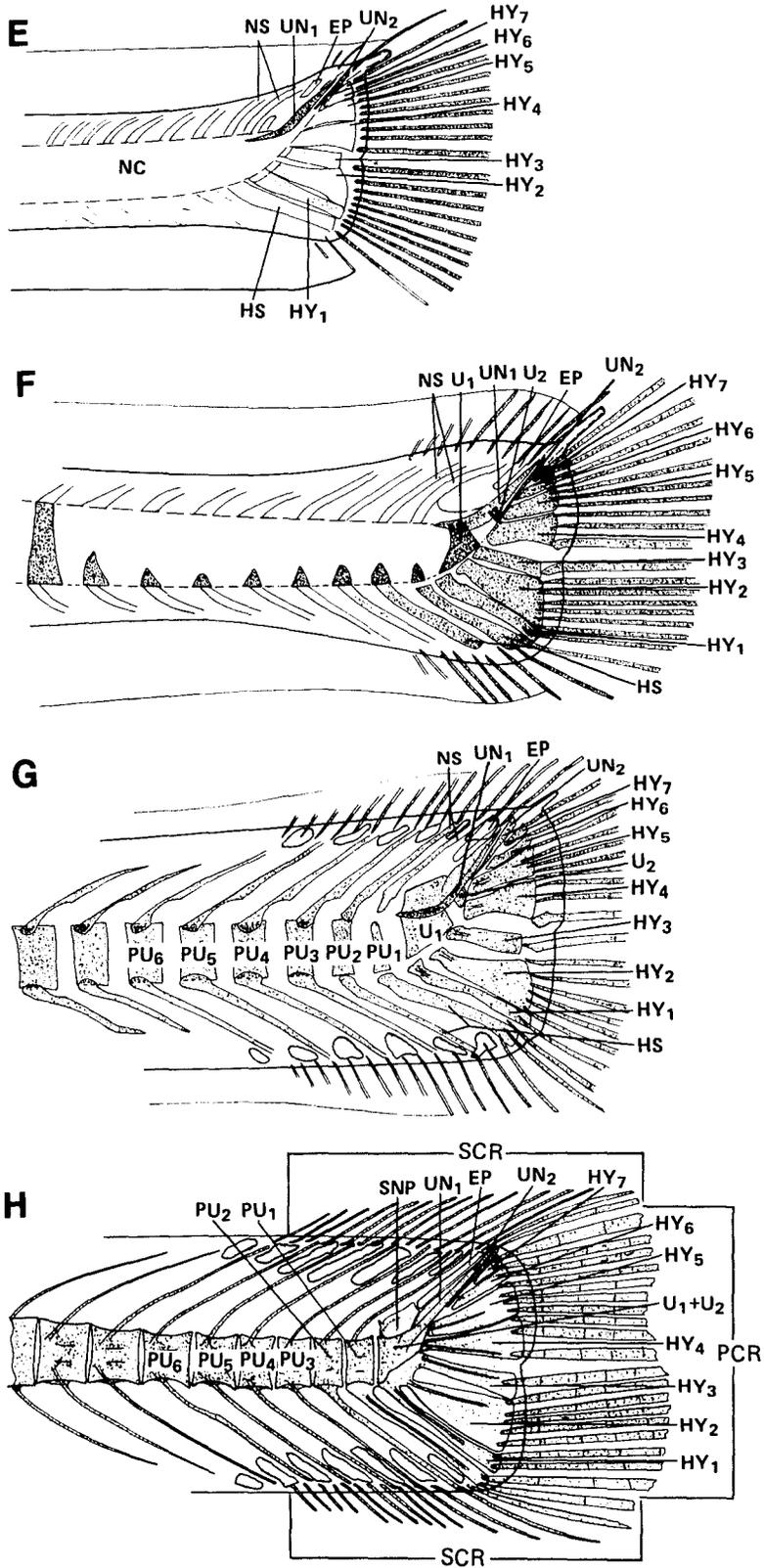


FIGURE 4.—Development of the caudal fin of *Leuroglossus schmidti*: A, 6.4 mm SL; B, 11.5 mm SL; C, 15.3 mm SL; D, 18.4 mm SL; E, 23.1 mm SL; F, 30.6 mm SL; G, 35.1 mm SL; H, 51.6 mm SL. Ossified elements are stippled. NC = notochord; HY = hypurals; EP = epural; HS = haemal spine; UN = uroneural; NS = neural spine; U = ural centra; PU = preural centra; SNP = specialized neural process; PCR = principal caudal rays; SCR = secondary caudal rays.



adult complement of 10+9 principal caudal rays is consistently ossified in 29-30 mm larvae, but secondary caudal rays are not completely developed until after transformation. In a 30.6 mm specimen (Fig. 4f), ural centra 1 and 2 are ossifying as are two neural spines associated with preural centra 1 and 2 and haemal spines associated with preural centra 1-4. The bases of preural centra 1-8 are beginning to ossify.

In a 35.1 mm transformed juvenile, all centra of the caudal complex, preural and ural, are ossified as is the specialized neural process (Hollister 1936) dorsad to U_1 (Fig. 4g). Ural centra 1 and 2 are still separate. Neural and haemal spines and principal and secondary caudal rays are fully ossified. The hypural bones are separate and autogenous in this specimen. A 51.6 mm juvenile has ural centra 1 and 2 fused into a single urostyle (Fig. 4h). The single epural is beginning to ossify and hypural bones 1-3 are fused together at their bases and ankylosed to the urostyle. Hypural bones 4-7 are still autogenous in this specimen. In this specimen, the 10 superior principal caudal rays are distributed as follows: hypural 7, one ray; hypural 6, two rays; hypural 5, four rays; hypural 4, three rays. The inferior nine principal rays included one ray on hypural 3, five rays on hypural 2, two rays on hypural 1, and one ray on the posteriormost haemal spine. During the development of the caudal fin, the ventralmost principal caudal ray is associated with hypural 1; it apparently is displaced to articulate with the ultimate haemal spine in some, but not all, juvenile specimens.

Dorsal and anal fin rays ossify rapidly during transformation as do pectoral and pelvic fin rays (Table 3). It was not possible to follow the sequence of ossification of individual rays in these fins. The adult complement of dorsal, anal, and pelvic fin rays is present on the smallest transformed specimen. The adult complement of eight to nine pectoral rays, however, is not present in all transformed specimens examined. Scales are not present in a 55.0 mm juvenile, but they are reported to be deciduous (Hart 1973), and hence, may have been lost during capture.

COMMENTS ON THE VALIDITY OF THE GENUS *LEUROGLOSSUS* GILBERT AND THE SPECIFIC STATUS AND NAME OF *L. SCHMIDTI*

The results of this study offer support for the validity of the genus *Leuroglossus* Gilbert which

has been questioned. Gilbert (1890) erected the genus *Leuroglossus* in the family Argentinidae for specimens from the Gulf of California that he described as *Leuroglossus stilbius*. Chapman (1943) reviewed *Leuroglossus* Gilbert, removed it from Argentinidae, and placed it in Bathylagidae. Cohen (1964) synonymized *Leuroglossus* Gilbert with *Bathylagus* Günther. Borodulina (1968) stated *Leuroglossus* lacked an orbitosphenoid bone, although Cohen (1964) said it was present in *Leuroglossus* and used its presence as a generic character for *Bathylagus*. Borodulina (1969) later described the osteology of *L. schmidti* and compared it with *B. pacificus* (based on Chapman 1943). She stated that *Leuroglossus*, in contrast to *Bathylagus*, lacked an orbitosphenoid, possessed teeth on the palatine, had three denticles on the last pharyngobranchial, and possessed antorbitals. Ahlstrom (1969) described differences in the movements of oil globules between *Bathylagus* and *Leuroglossus* eggs which, with the lack of an orbitosphenoid in *Leuroglossus* (as reported by Borodulina 1968), he felt, lent additional support to the validity of *Leuroglossus* as a genus distinct from *Bathylagus*.

My samples of *Leuroglossus* lacked an orbitosphenoid, whereas those cleared and stained specimens I examined of *Bathylagus* did possess an orbitosphenoid. Specimens of *B. pacificus*, *B. ochotensis*, and *B. milleri* I examined lacked teeth on the pharyngobranchials, whereas *Leuroglossus* possessed three teeth on the fourth pharyngobranchial.

Based in part on the lack of an orbitosphenoid in *Leuroglossus*, the presence of one in *Bathylagus* and the differences in the movements of oil globules in the eggs of these two genera, as reported by Ahlstrom (1969), I follow Borodulina (1969) and Ahlstrom (1969) in considering the two genera distinct. The number of valid genera in the Bathylagidae and analysis of their relationships, however, await further study of the entire family.

This study provides additional evidence to recognize *L. schmidti* as a species distinct from *L. stilbius*. Rass (1955) described a northern subspecies, *L. stilbius schmidti*, from the Kurile-Kamchatka Trench, based on morphometric measurements which differed from measurements described by Gilbert (1890). Cohen (1956) synonymized *L. s. schmidti* with *L. stilbius*, asserting that the proportions used by Rass to describe *L. s. schmidti* were size dependent. Borodulina (1968) pointed out that *L. stilbius* had

39-42 vertebrae, whereas *L. schmidti* possessed 49-51 vertebrae. Borodulina (1968) considered *L. schmidti* to be a subspecies of *L. stilbius*, although she suggested that *L. schmidti* might subsequently be recognized as a separate species, a suggestion that she did not pursue because of insufficient material. She also considered *L. urotranus* (Bussing 1965), described from the Peru-Chile Trench, to be another subspecies of *L. stilbius*. Ahlstrom (1968) noted the differences in vertebral counts in *L. stilbius* and *L. schmidti*. Subsequently Ahlstrom (1969) pointed out the differences in egg size, pattern in migration of oil globules during embryonic development, larval pigment, and body proportions between *L. stilbius* and *L. schmidti* which, along with differences in vertebral counts, he felt, enabled recognition of *L. schmidti* as a distinct species.

Peden (1981) examined vertebral numbers in *Leuroglossus* from samples collected from Mexico to the Aleutian Islands and westward to Japan. He noted that samples of *Leuroglossus* from British Columbia waters had an average of 8.5 more vertebrae than those samples collected off Oregon. He therefore recognized *L. schmidti* as distinct from *L. stilbius stilbius*. As presently known, the geographical ranges of the two species do not overlap, as discussed below. Based on the differences in vertebral counts in the two nominal species reported by Borodulina (1968, 1969) and Peden (1981), the evidence presented by Ahlstrom (1968, 1969), and the results of this study, I consider *L. schmidti* specifically distinct from *L. stilbius*.

The valid name of the northern smoothtongue is considered here to be *L. schmidti*, rather than *Therobromus callorhini* or *Leuroglossus callorhini*. *Therobromus callorhini* was described by Lucas (in Jordan and Gilbert 1899) from bones extracted from fur seal stomachs collected in the Bering Sea. He noted that the specimens had 26 precaudal and 23 caudal vertebrae and placed the species in Osmeridae. Chapman (1941) showed that *T. callorhini* was not an osmerid and later (Chapman 1943) he suggested that *T. callorhini* (emended to *callorhinus*) was most likely identical with either *Bathylagus pacificus* or *B. alascanus* (= *B. milleri*). Cohen (1964) synonymized *Therobromus* Lucas with *Bathylagus* Günther. Ahlstrom (1968, 1969) suggested that the correct name of *L. schmidti* was *Leuroglossus callorhini*, but did not formally propose such a synonymy.

If the two names do refer to the same species,

then *L. schmidti* is a junior synonym of *T. callorhini*. The type material of *Therobromus callorhini* Lucas apparently no longer exists (according to D. M. Cohen⁷). However, as the name *T. callorhini* has apparently not been used as a senior synonym in more than 50 yr (Chapman 1943), *T. callorhini* constitutes a *nomen oblitum* according to the International Code of Zoological Nomenclature (Stoll et al. 1964). Hence, I consider the valid name of the northern smoothtongue to be *Leuroglossus schmidti*.

OCCURRENCE OF EGGS AND LARVAE OF *LEUROGLOSSUS SCHMIDTI*

(Figure 5)

Eggs and larvae of *L. schmidti* are broadly distributed in near-coastal waters from about southern Vancouver Island, British Columbia, to the central Bering Sea. In midocean they are apparently distributed as far south as lat. 46°N, since eggs and larvae of *L. schmidti* were collected in 1951 and 1955 from about lat. 46°-57°N and long. 149°-179°W (Ahlstrom 1969; Moser⁸). They have apparently not been found in coastal waters off Oregon, however, as the relatively few specimens of *Leuroglossus* larvae, collected off Oregon by Oregon State University, consisted exclusively of *L. stilbius stilbius* (Richardson 1973; Washington⁹). The results of an ichthyoplankton survey conducted in October-November 1971 from off Washington (lat. 46°45'N) to Dixon Entrance, British Columbia (lat. 54°30'N), were reported by Naplin et al. (footnote 4). Eggs of *L. schmidti* were found only north of lat. 53°N off Queen Charlotte Islands, whereas only *L. stilbius stilbius* eggs were collected south of lat. 51°N off Vancouver Island and coastal Washington. The few *Leuroglossus* larvae collected during this cruise were all *L. schmidti*, and they were taken only north of lat. 54°N. Possibly the eggs identified as *L. stilbius stilbius* off Vancouver Island

⁷D. M. Cohen, National Systematics Laboratory, National Marine Fisheries Service, National Museum of Natural History, Washington, D.C. (present address: NWAFC, NMFS, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112), pers. commun. July 1980.

⁸H. G. Moser, Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, La Jolla, CA 92038, pers. commun. March 1980.

⁹B. B. Washington, School of Oceanography, Oregon State University, Corvallis, Oreg. (present address: Gulf Coast Research Laboratory, Ocean Springs, MI 39564), pers. commun. November 1980.

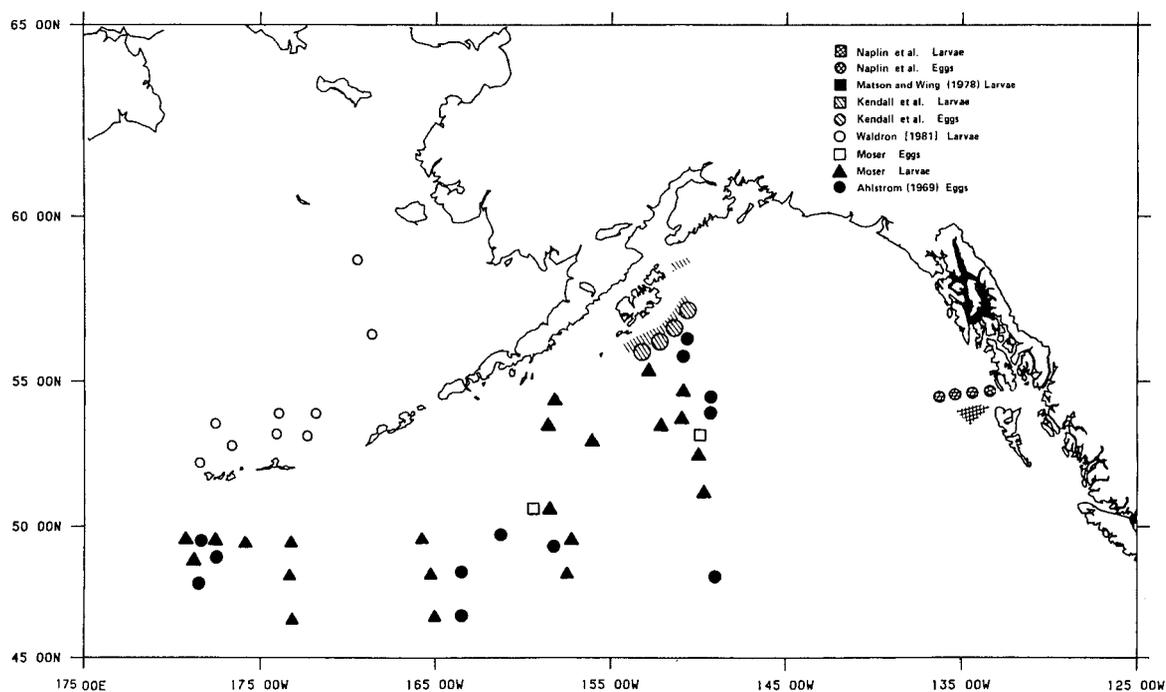


FIGURE 5.—General areas where eggs and larvae of *Leuroglossus schmidti* have been reported. Key: Naplin et al. (text footnote 4); Matson and Wing (1978); Kendall et al. (text footnote 3); Waldron [1981]; Moser (text footnote 8); Ahlstrom (1969).

could have been transported northward from more southerly spawning areas. During this cruise, surface geostrophic currents indicated a 6 cm/s northward flow offshore from about lat. 47°N to 51°N (Naplin et al. footnote 4).

Leuroglossus schmidti larvae were the third most abundant fish larvae collected in plankton samples from coastal waters of southeastern Alaska (lat. 56°50'–59°28'N, long. 133°10'–135°23'W) in April–November 1972 (Mattson and Wing 1978). This species accounted for 4.5% of the total catch of fish larvae; abundance was high from May to August, peaking in June and July. Plankton sampling in Kodiak Island shelf waters from November 1977 through March 1979 revealed that eggs of *L. schmidti* were found principally at the shelf break (water depth >200 m); abundance was greatest in the fall, but eggs were found in small numbers in summer and winter (Kendall et al. footnote 3). Larvae were also most abundant over the shelf break in the fall, but seasonal abundance was not determined. Waldron [1981] summarized available distribution data on larvae and juveniles of *L. schmidti* occurring in the eastern Bering Sea from 1955 to 1978. Based on plankton sampling conducted by the United States, U.S.S.R., and Japan (primarily

during summer) utilizing a variety of sampling devices, larvae identified as *L. schmidti* were most frequently reported over the shelf break.

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